What Values do Middle School Students Attribute to Studying Mathematics: A Pilot Study

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In 2005, the meeting of all federal and state ministers of education in Australia issued a statement under the title National Framework for Values Education (Australian Government, 2005). The Framework includes a vision of values education and a set of values to be developed by all Australian schools. Values education is not conceived to be implemented in a specific subject but the framework calls for "incorporating values into all school policies and practices, including teaching programmes across the key learning areas" (p. 2). In other words, values education is "an approach to existing curriculum, a way of seeing curriculum that requires integration rather than an addition" (Curriculum Corporation, 2008). Further, the Australian federal and state ministers of education signing the Melbourne Declaration on Educational Goals for Young Australians assert that "parents, carers and families are the first and most important influence in a child's life, instilling the attitudes and values that will support young people to participate in schooling and contribute to broader local and global communities" (p. 10). However, they assert that schools will continue to play a role in developing national values for the society.

There is wide agreement in research and government policy that values are intrinsic to educational curriculum (Apple, 2000) and pedagogy (McLaren, 1998). Lovat and Clement, (2008) assert that "values education [should] be at the heart of all pedagogical and curricular ventures and that any educational regime that sets out to exclude a values dimension in learning will be weakening its potential effects on all learning and student wellbeing, including academic learning" (p.13).

More recently, in 2008 the Australian Government established the Australian Curriculum, Assessment and Reporting Authority (ACARA) with the mandate of developing of a National Curriculum to achieve uniformity between the States curricula. The ACARA developed the Shape of the Australian Curriculum document (National Curriculum Board, 2009a). The document identifies the development of values as a national educational goal. ACARA selected Mathematics as one of the first three curricula to be developed, the first draft being released in 2010 (National Curriculum Board, 2009b). However, little up to this point has been done to focus the general call for incorporating values teaching into core subjects of English and mathematics. Hence, this is an opportune time to study the incorporation of values in mathematics in line with national aspirations.

The construct of values has only recently entered the literature in mathematics education. Arguably this is a result of a long standing tradition that sees mathematical objects as objective facts and mathematical proofs as rational, and hence independent of human history or personal interests (Bishop, 1991a). Similarly, the importance of

mathematics in the general school education is often assumed and unquestioned (National Curriculum Board, 2009b). However, the teaching of mathematics is frequently the subject of public debate and critique because of the perceived poor student achievement on national testing, the decline in number of young people who pursue further study in it, and for the aversion and anxiety experienced by many adults in dealing with mathematical situations. The question about the value of mathematics is made more complex by the changing nature of the workplace and technological developments that has made much of the traditional mathematics invisible (Jablonka & Gellert, 2007).

We commence by identifying various perceptions and locations of values in mathematics provided in the literature. Bishop (1991b) identified four organisational levels of where values are exhibited: the societal level (e.g. official curricula and entry requirements); the institutional level (e.g. its role in school curriculum and organisation); the pedagogical or teaching level (e.g. stressing one aspect of mathematics rather than another); and the individual level (e.g. the personal importance that a student places on achieving best results). Similarly, Bishop (1996) differentiates between types of values as relating to mathematics as a discipline (e.g. rigor or logical argumentation), to education in general (e.g. honesty) and to mathematics education itself (e.g. neat presentation).

The work of Bishop and others in Australia has been very influential in evolving an active area of research around the world on values in mathematics education. In the early 2000s, the ARC-funded 'Values and Mathematics Project' led by Bishop and Clarkson with involvement of Seah investigated the range of values espoused by classroom teachers, and found that partly due to the lack of a shared language, teacher awareness and control of what they value in mathematics teaching practice can be enhanced (Bishop, FitzSimons, Seah & Clarkson, 2001). Another ARC-funded project in the mid-2000s examined the values that are differentially held by teachers and students in mathematics and science. In that project, Bishop, Clarke, Corrigan and Gunstone's (2005) experience with the teacher participants reveals that the values that were portrayed were influenced by their respective disciplines of mathematics and science. Values represented in mathematics textbooks in countries such as Australia, China, Turkey and Vietnam have also been examined and it was found that the espoused values were dependant to some degree to culture (see Cao, Nguyen, & Bishop, 2002; Cao, Seah, & Bishop, 2006; Dede, 2006). More recently, research studies have been directed to how these can be utilised to foster mathematical wellbeing (see Clarkson, Bishop, & Seah, in press), and the extent to which particular commitments are co-valued by teachers and their students across eleven nations and regions (see Seah, in press).

Undoubtedly, it is critically important to study the implicit or explicit values in mathematics education. It is highly likely that a match between the values that the students have and the values reflected in mathematics curricula and classrooms might lead to more engagement in and enjoyment of studying mathematics. However, much evidence in the classroom show that some students say they don't enjoy mathematics yet they persist in studying it because of its value to their career aspirations, while others who do not see a need for mathematics may stop its study even though they may like it. Hence the relationships between the values in mathematics and decisions to study mathematics are not very straight forward.

Therefore, in this study we are interested in values *of* mathematics, rather than values *in* mathematics which was the focus of the above research, that students, teachers and indeed curriculum have as possible understandings of students' decisions in pursuing its

study. Further, we argue that considerations of the values of mathematics also can provide normative criteria in making decisions about what mathematics curriculum and teaching should focus on. We will consider each of these implications of studying values *of* mathematics in turn.

Students are more likely to continue to study mathematics and put in greater effort to succeed in it based on their perceived value of mathematics and its relevance to their life aspirations as much as on their ability and enjoyment (Atweh & Brady, 2009; Luttrell et al., 2010). As Luttrell et al. (2010) argue, educational reform to improve teaching and learning is not likely to have long term impact if students don't value mathematics. The authors point to previous studies that show that "the perceived value was more important than expectations for success in keeping students cognitively engaged" (p.144). The authors developed an instrument with four dimensions: students' interest in studying mathematics, their perceived utility of mathematics, their motivation to obtain high grades and the personal cost of mathematics study. Undoubtedly such an instrument is useful to understand students' motivation to study mathematics. However, being a quantitative instrument, it presents a very general measure of students and fails to investigate in depth factors that determine their views; and more importantly, it is not useful to inform teaching and learning in the discipline. Hence it is argued here that what is now needed is an investigation to depth the views from a variety of stakeholders and the effect of appropriate classroom practices on increasing students' valuing of a nationally essential subject as mathematics, their engagement and learning in it.

Atweh and Brady (2009) point out that there is a general acknowledgement that mathematics is an important subject in the curriculum and in the current and future lives of students. In the minds of many, such importance is given to the subject due to the increasing importance of technology and science two essential areas in problem solving and raising living standards. Mathematics, like science, is often associated with economic development of a country (Kuku, 1995). At the personal level of the student, mathematics is often justified as opening the doors to many careers and courses of further study.

However, Atweh and Brady (2009) argue that these assumptions about the value of mathematics education for the student and society should not be accepted uncritically. First, the relationship of mathematics to general economic development is far more complex than is often assumed. For example, Woodrow (2003), citing the example of the development of the Asian economies and the high achievement by their students in international testing, argues that increases in mathematics education standards have occurred after their economic development, and arguably as a result of it, rather than the other way around. Further, Ortiz-Franco and Flores (2001) demonstrate how during the period between 1972 and 1992, the mathematics achievement of the Latino students in the USA have increased in comparison with the other students, however their socioeconomic status has decreased.

Similarly, the assumption that mathematics is needed to increase access of students to jobs as a justification of its place in the curriculum should be regarded with care. The dominance in school mathematics of content needed for careers that are seen as mathematically based – mainly science and engineering, is unwarranted and, perhaps, is a residue of times when few students finished high school and went to university. Notwithstanding the importance of jobs in science and engineering for social technological development, only a few students end up in such careers. Further, with advances in technology, the demand for most calculations and algorithms that still dominate the

majority of school teaching are increasingly becoming obsolete. Indeed, Jablonka and Gellert (2007) point out that, in certain areas, mathematics has become mostly invisible due to the wide spread of technology. Arguably, the nature of mathematics used in society has changed more rapidly than school curricula. This leads to our argument that all students need considerable amount of mathematics for effective citizenship in the increasingly mathematised world of today – albeit a different type of mathematics that might be focused upon in schools. Not only a significant amount of mathematical thinking is behind most day-to-day decisions that people make, but also as Skovsmose (1998) asserts, mathematics plays a role in "formatting" the world. In other words it creates a social and physical world after its own image. This power of mathematics is, of course, double edged. On one hand, great achievements in science and technology are mathematically based. But also mathematics is implicated in technologically caused catastrophes such as wars, mass destruction and environmental degradation (D'Ambrosio, 1998). Hence, a *utilitarian* approach to mathematics falls short of developing students as responsible citizens. As Ernest (2002) argues a critical approach to mathematics and citizenship is needed. This ethical response-ability discussion applied to mathematics education posits the primary aim of mathematics education to enable the response-ability of students in their current and future lives as citizens.

Developing mathematical knowledge and capacity helps the students to not only, using Freire's (in Gutstein, 2006) terminology, "read the world", i.e. understand it, but it should lay the foundation for their capacity to "write the world", i.e. change it. In traditional wisdom of school mathematics, reading the world (at least some aspects of it) is the function of the school; while writing the world is often constructed as a possible capacity that might arise later when the students enter the workforce and civil society. Borrowing the terminology from Down, Ditchburn and Lee (2007), the role of mathematics education as it relates to citizenship can be at three levels. Mathematics education can contribute to the ability of students to function as effective citizens in the world. The authors call this a *conforming* ideal. This is consistent with the dominant justification of mathematics as developing skills and knowledge useful for preparation for work. However, mathematics can also be used to enable students to understand how the world works (or does not work) in order to change some aspects of their world. This, the authors refer to as *reforming*. However, mathematics has an additional capacity. It can be used to create the world in a new way. The authors call this the *transforming* capacity. This focus on mathematics education is consistent with the critical mathematics movement.

The Pilot Study

The small scale study reported here is part of a larger project that aims at investigating the

1. values of mathematics as seen by students, parents, and teachers and their relationship to a) national curriculum documents and policies b) classroom practices and c) social factors such as gender, socioeconomic and cultural backgrounds;
2. principles for effective curriculum activities and pedagogies based on the explicit integration of values of mathematics and the effect on students engagement in it and learning; and

3. professional growth of teachers as they explicitly integrate values of mathematics in their practice.

Our specific aims in the pilot were a) trialling the instruments to be used in the main study and b) identifying the main issues raised by the students with relation to the value of mathematics rather than reach an in depth and comprehensive view of the values held by young people. In this paper data related to the second aim only will be considered.

In this Pilot study we identified four schools, two from Victoria and two from Perth. All four schools were private schools with a certain amount of focus on academic standards. All schools were single gender schools, two for boys and two for girls. Gender is an important factor in determining experiences and attitudes to mathematics (Atweh, Bliechard & Cooper. 1998). However in this preliminary analysis we will not consider it. In each school we identified one collaborative teacher of year 9 (age 14) who assisted in the selection of a group of 5-7 students for a focus group. The students were selected on the sole criteria of being articulate and confident in discussing their views with university researchers. Hence, in selecting the schools and the students, we have not attempted to cover a whole spectrum of students' backgrounds and interests.

An initial focus group schedule was developed to be used in the four schools. The schedule contained general questions about the values of mathematics education that the students, parents and teachers seem to have from the perspective of the student. Opening questions would lead into further questions to clarify the points raised by the students. Each focus group lasted approximately 50 minutes. The interviews were tape recorded and transcribed**.**

Qualitative data analysis based on grounded research techniques (Strauss & Gorbin, 1990) was used. Codes were developed from the interviews and grouped into more abstract categories. Some of the categories arose from the data while others from the literature review conducted. Due to the small number of interviews the analysis was conducted manually.

Preliminary Findings

In this section we will discuss the findings on two themes stemming from the data: the value of mathematics and relevant pedagogy. In the first theme we will consider the question of how did these students see the value of mathematics they were studying. Under the second theme we will consider their views about pedagogy in the classroom as it promoted the values of mathematics.

Prior to the analysis, we point out that, as expected, while there were commonalities in many of the views expressed, the students did not speak in a unique voice. There were some differences in opinions and expectations. However, in this pilot study we were interested in identifying the themes to be investigated in the main project rather than looking at investigating differences and how they arose. Hence, in this analysis we will consider the important issues that arose irrespective of the strength of adherence to them.

Value of mathematics

As was to be expected, most students in the four schools expressed a high regard for the value of mathematics in the overall curriculum in school and in their future lives. Some went as far as asserting "maths is one of the main skills so one of the main skills in life to get somewhere" (AC. p. 4). The value of mathematics is often assumed and is often not, or does not need to be made explicit.

> I think the main [idea is that mathematics is important], it's like an underlying message they don't actually say, but I think it's that the world is centred around maths, you know, you go to the shops to buy something, do you have enough money? And I think that's why maths is such an important core subject and I think that even though the teachers don't directly say that to you it's there, everyone knows it. (GI. p.10)

The students were able to identify many areas in adult life that mathematical knowledge and skills are useful. For example, shopping (AC. p.10), handling money (AC. p. 15), undertaking personal accounts (AC. p.15), and preparing tax forms (AC. p.10). It is interesting to know, that the majority of examples they gave related to numbers and operations on them. More importantly, most have related to what can be considered low level mathematical skills that can easily be done using the available technologies. Even in examples that they have given the may depend on special ability, all they can think of was about numbers.

> With our glazing we're doing our clay sculptures we had to mix stuff together add water if it was too runny and you need to know how much or and then when putting together frames for a painting that you want to make yourself like a canvas or as well where ... we had to put together our own frame so we had to measure all that up and use our maths and that. (AC. p.15)

Perhaps the only exception to this low level mechanical mathematics that the students have mentioned was related to problem solving. One student commented "It helps you because most of maths is problem solving and, I guess, you just learn to problem-solve better and read the question" (PC. p. 5). However, even in this case, one can't help but note the unrealistic expectation that in real life problems are like school mathematics problems whose solution depends on simply reading the problem correctly. Perhaps, this is simply a reflection of lack of ability by the student to articulate his point of view. However, as we will argue below, it points to a more serious potential problem related to the lack of experiences in the school mathematics classes to deal with real problem solving - i.e. problems that are actually encounter in the world of politics, work, and lived experience by adults.

Secondly, the students identified their perceived value of mathematics for assisting in their future study at university. It is relevant to recall that all the students in this pilot study come from private schools that place a primary focus on academic achievement and many of the students expressed interest in keeping their options open for university studies. Arguably, relating mathematics to university study is a tool that many mathematics teachers use to motivate students for higher achievement in mathematics and as a justification of certain content in the curriculum. This is often accompanied by slight exaggeration in asserting that some content or high level high school courses is required for entry into certain courses at university, while in fact they are not prerequisites. One student volunteered her opinion with some qualification indicating a general acceptance of the value of mathematics for university access without being able to base it on exactly

knowledge: “Yeah, isn’t maths like [used] in a lot of uni courses, it’s like a prerequisite, that’s what I’ve been told if you want to get in” (WT, p10).

Related to entry to university, undertaking the highest levels of high school mathematics is often thought as useful to obtain highest high school scores on state testing regardless of the level of achievement in it. In some Australian states that is actually the case. One student expressed his belief that “If you get a higher score for [the Victorian Certificate of Education] VCE in mathematics you have a better chance of getting into courses that involve mathematics” (PC. p. 7). This, often, unwarranted stress on highest level mathematics subjects can create problems for some students. Fortunately, some teachers are aware of this situation and try to rectify it in giving advice to students. One student said:

> We had like a subject choices one and [our teacher] said you know that it’s not important to try an go for the [highest level mathematics] if you can’t handle it because he was giving examples of students where they’d gone for the highest one, got in but then they just couldn’t do it. They ended up not getting the marks and couldn’t go to Uni. [He] just had to stick with TAFE [Technical and Further Education college]. Where another guy just went for the base [level subject], one that he needed to get in. [He] did well in that [and was able to get into his chosen course]. (AC. p.10)

Third, a related value of mathematics for university entry is its perceived value in certain careers that the students might consider in their future lives. The students mentioned a few types of jobs, usually seen as higher status, that require mathematics. For example, as one student put it:

> [You need mathematics] if you’re going for a higher job like architecture or engineering. Something where you needed to learn mathematics and algebra and all that then it would be important but if you’re just going for like an army job or something you wouldn’t necessarily need it. (AC. p. 6)

Even for those who are not planning to go into those careers, mathematics is seen as valuable for keeping options open and for promotion in the workplace:

> Yeah but if you get better maths then you’ve got more opportunities than if you were kicked out of that job then you can go to something else. You can move up the rank a bit if you want. (AC. p. 6)

This connection of mathematics to future options was very strong in the minds of many students. Arguably, messages from parents and teachers always point out to this as an encouragement to students to pursue and excel in studying mathematics.

S: So if you keep going with Maths it doesn’t like close any options, it can, you can like keep your options open with what you want to do if you can do that.
I: [you mean] with a good [grade] it does allow you to choose a big range of subjects
S: That’s what I do. (WT. p.13)

However, there were some concerns expressed by the students about focusing the value of mathematics on future careers. One student felt that the focus on careers may justify certain content in the mathematics curriculum. However, he felt that may lead into lack of focus on the mathematics that is needed by everybody in their daily life.

S: See it’s the more complicated things that I don’t understand the point of, see if you’re in a particular place like say construction, you need to know certain mathematical things that apply to that or if you’re in accounting or if you’re in

whatever. *It's the things that generally apply to everyone that I don't think we get*, do you understand...?

I: So the daily life sort of things?

S: Yeah, see the only thing I can think of is like percentages and working because you need them a lot sometimes and addition, and you know, basically I think it's really basic things that apply to us every day. Whereas everything else is quite job specific so that's why. (italics added for emphasis) (WT. p.13)

This student raises an important issue about the standard curriculum and teaching in many schools around the world. Perhaps the student could not articulate his concern very well due to his level of maturity. However, such difficulty in identifying the value of mathematics in real life is perhaps a problem with many adults as well. What might be a great concern here is the possibility that he could not think of many applications of mathematics to everyday life, except percentage and numbers, because the focus on teaching mathematics in his school has not made such connections explicit. We will return to this point in the discussion of the next theme of the data.

Before we go on to the other values of mathematics for these students, we need to comment on the above three values identified by the students. All three values relate to the future of the students. One student put it this way "That's [it] basically, yeah [the teachers] try to explain to us how it applies in future and why we need it" (WT. p.10). While they may be based on some truth, students have to accept them in faith or trust in the adults. It is not possible in their development to know for sure how mathematics is useful for life, university study or careers. For many students this is not sufficient.

S1: That's why some people don't pay attention in maths because they don't think they need it.

S2: Why do we need algebra, we're not going shopping.

I: Do you get good questions, I mean do you get good answers to those questions?

S3: No.

S4: No.

S5: We get very vague answers - like it's applies to you in future and we're like yeah? How?" (WT. p. 10)

Teachers sometimes "can't even answer where you're going to use it" (PC. p. 4).

Perhaps due to this futuristic focus on the value of mathematics lead some students to naively expect that the role of algebra is for general household shopping. Another student said, "Stuff like … we did [in the] statistics [topic] we probably won't be doing much with that [in future life]" (WT. p. 10). Another difficulty identified by the students about valuing mathematics on base of future needs, is that, even at that young age some of them have formed an idea of what type of careers they were interested in already – keeping their options open notwithstanding.

The fourth value of mathematics identified by the students, and the only one that does not relate to their future lives is that mathematics is useful in other subjects. As one student said that is learning mathematics, "we got able to use it in other classes quicker and able to understand maths with everything else with it" (AC. p. 4). Naturally some students pointed out the use of mathematics in subjects as science. While several students mentioned the use of mathematics in other subjects, one student related a real specific experience in using mathematics in other subjects. "Well, because in Home-Ec [i.e. Home

Economic, sometimes called Domestic Science], the other day I was making a cape for my doll and we knew her neck measurement but we didn't know how big to make it so we used π to find the radius" (GI. p.11).

Finally, how do students respond to this lack of certainty about the value of mathematics in their life? Some students decide early that mathematics does not make sense to them at all, hence they opt for the lowest level of mathematics the first chance they have. Others tend to have no option but "just have to go with the flow basically" (PC. p. 6). While others said "but sometimes maths for me gets a bit repetitive and a bit boring but I still do it because I need it" (WT. p. 17).

Relevant Pedagogy

In general the students were very positive about their current mathematics teachers and their experiences in the classroom. Several students expressed opinions about their teachers along these lines "My mathematics teacher he really cares about us" (AC, p.2); and "They show respect by, I don't know, listening to us and understanding us, I suppose" (PC. p.2). Undoubtedly this positive relation is important for students to be able to develop a sense of trust with their teachers that allow them to deal with any potential problems to deal with the subject. One student put it this way:

> I think that it's important that the maths teachers have a good relationship with students and that we want to go to maths, not only because maths is cool, because you know it's going to be a fun session and I think it's good that they have lots of encouragement for you, most of the time. (GI. p. 2)

Most students agreed that their teachers place a high value on their understanding the content rather than just being able to do the exercise and obtain the correct answer. They sought teaching methods that "everybody can comprehend" (WT, p1.). However, not always is this focus on understanding successful. Some students point out that different students have different learning styles. They point out that some students "might understand maths by the teacher just [explaining it in a] straightforward [way]" while others "understand maths by actually doing [it] like hands on activities" (WT p.1).

Teachers' focus on understanding in mathematics often emphasised seeing connections with other content and seeing the structure of the content. This focus can be demonstrated by the emphasis on detailed explanation and its repetition. This, however, can be very frustrating for some students.

I: Okay so anyway they seem to value understanding - that was something that was mentioned by a few of you - so do you agree that this is important?

S1: Yeah.

S2: But sometimes like when you come to them with a problem they seem to, well this is what I think, they like explaining too much of it, like you only want to certain section of it but they value teaching the whole thing because they think you don't get it.

S3: And that's when it gets confusing when you learn stuff...

S1: I like having the overview and then the parts explained and a lot of maths, I suppose the easiest way to teach it is in stages whereas I like to have the

overview and then have the little parts explained to me. And sometimes you want this part explained and they explain the whole thing. (WT. p.8)

While the students appreciate how mathematical ideas can apply in their daily lives, they were not always certain how. As one student said, "so yes, it [mathematics] does apply, I just want to know how sometimes" (WT. p.10). Teachers are not necessarily helpful in this regard: "we're not getting [any explanation how the mathematics applies], like we have to go and find it ourselves …. You can kind of tell when they [the teachers] give you that dumb stare before they answer" (WT. p. 11).

At times teacher's attempts to make mathematics fun and applied comes across as rather artificial. One student described it as an act of "desperation" (WT, p.2) on the part of the teachers trying to make mathematics practical. Some students saw that teachers attempts to make mathematics relevant not necessary as something that the teachers value, but rather due to curriculum demands:

S1 Well I'm not sure if they value it more it's built into the curriculum now because it's not just here it's a value so I know a lot of schools that...
I: But that's interesting thing because they may not value but...
S1: They have to do it.
S2: They have to do it.
S1: Because it's part of the state curriculum now because I know a lot of schools that do the same thing. (WT. p.7)

One group of students recalled an activity that the teacher planned using Barbie dolls that involved determining trajectory of the doll and the distance it would travel when dropped. It seems that the aim was to illustrate the algebraic linear functions. Many students in the group talked about their "distraction" by the context of the activity that positions the mathematical content all but secondary. Another student talked about curriculum requirement of teachers to have 'hands-on' activities that aims to make mathematics relevant, understandable and perhaps fun. Another attempt by the teacher for creating fun activities in this classroom was the development by students of a board game. Most students insisted that this was not engaging. One student put it this way: "Most probably [there was] a point [behind the activity] and we probably learnt something. But, we don't know that we did, so there is really no point in having [it]" (WT. p.5).

Another technique that teacher used to make mathematics 'real' and interesting is to take a historical approach. One focus group reported about learning "something about the life of Pythagoras.

I: Is that interesting or not?
S1: No.
I: Or is that relevant or not?
S1: No.
S2: Every now and then it is, because I like history but I really didn't need to know about Pythagoras.
S3: You don't really need to know the history; you just need to know how to do it. (WT. p. 12).

Often the teachers' attempts to make mathematics relevant to the students fail to inspire students about the use of mathematics in real life. One student related the story of

going to camp and doing some mathematics activities there. They had to measure height of a mountain. Perhaps sarcastically he asked "Why would you need to get the height of a mountain when you've got maps or something?" (PC. p. 10).

Teachers often find it difficult to show the applications of all content of the curriculum in mathematics. Applications are often hit and miss and used to supplement the curriculum rather than a way to teach the content. While students could see some relevance of some of the content, they still maintain that "some [topics] are pretty pointless" (PC. p. 4). When the real applications are not available, there is always the threat that they need the content for good results on exams.

> Our maths teacher certainly tells you, "Well, you need to know this for everyday life but you don't really need to know that." And there's also the bits where it's mostly you have to work out the question otherwise you won't get marks and that's probably showing the working out's most of the marks. (PC. p.4)

We note again that these teachers are employed by academically oriented private schools usually because they have a relevant and good track record as successful mathematics teachers based on students' results. The above students are commenting on what in many respects would generally be regarded as good teaching environments.

Conclusions and Discussion

The above analysis from our pilot study aimed at obtaining students views about the value of mathematics to their lives and to their views about classroom pedagogy that promotes these values. The four groups of students came from what can be called privileged private schools that put high emphasis on academic achievement. Undoubtedly their parents were ready to incur the cost of their children's education with the intention of them getting good education that opens the doors for further study and good careers that they may follow. Care should be taken in attempts to generalise their views to other groups of young people their age.

In general the vast majority of the students expressed a very positive experiences and attitudes towards their teachers. In this pilot study we have not interviewed the teachers; hence the students' views are not triangulated with those of their teachers. Nevertheless, students' views and attitudes by themselves are important to study as they determine their decisions to engage with mathematics and for what reason.

There was sufficient evidence that these students did value mathematics as a useful subject for their future lives. This included university entry and the related future career options. They seem to agree that mathematics is also important knowledge in their future day to day living. However, they were less able to give examples besides day to day dealing with financial aspects of life in which mathematics is useful. Most of their examples included applications of what can be called low level mathematics involving numbers and their operations. Even in the case that problem solving was mentioned, it portrayed a naive appreciation of what word problems may look like in real life. However, the vast majority of the values of mathematics that the students hold relate to their future lives. Students did not seem to be able to articulate the role of mathematics to understand their world and be able to effectively influence that world as the literature above indicates. Of course, this may be explained by the lack of the verbal ability of the student to do so, even though the students were selected as being articulate and being able to express themselves with a

university researcher. However, the concern here is that they are not able to see the value of mathematics to read and write the world because of the way they are learning mathematics. This brings us to the second theme of the analysis.

There is sufficient evidence from these focus groups, that the students had very positive relationship with all their current teachers and that they valued their relationships with the teachers. Similarly, many students have mentioned that their teachers have placed a high priority on students understanding of the content. This focus on understanding was more related to clear explanation and repetition rather than develop understanding through applications. There were several techniques that teachers have used to make mathematics real and relevant to the students including, historical background of the content and some hands-on activities. However, the students at times failed to see the mathematics behind these activities or failed to see a real purpose of these activities in that they failed to relate realistically to their own lives or the lived experienced. It seems to us that the role of these activities in these classes were chosen more on a hit and miss basis for generating enthusiasm in students and to illustrate the content studied, rather than used to teach the content. Further, the activities used were seen by the students as artificial and lack authenticity to their current real lives.

Finally we point out to the overall view of the value of mathematics as assumed by the students, and perhaps by their teachers. In another context, Atweh (Forthcoming) argues that utilitarian understanding of the value of mathematics for careers and managing financial day to day affairs, fails to promote active citizenship of students and adults in society.

The dominance in school mathematics of content needed for careers that are seen as mathematically based – mainly science and engineering, is unwarranted and, perhaps, is a residue of times when few students finished high school and went to university. Notwithstanding the importance of jobs in science and engineering for social technological development, only a few students end up in such careers. The approach to mathematics taken here is that *all* students need considerable amount of mathematics for effective citizenship in the increasingly mathematised world of today – albeit different type of mathematics depending on their interests, capacities and career choices. Hence, a *utilitarian* approach to mathematics falls short of developing an active citizenship. As Ernest (2002) argues, a critical approach to mathematics and citizenship is needed. This ethical response-ability discussion applied to mathematics education posits the primary aim of mathematics education to enable the response-ability of students in their current and future lives as citizens. Here we will discuss two implications to the curriculum of mathematics that promote active citizenship.

Curriculum documents around the Western world often contain lists of outcomes or topic in mathematics that students are expected to cover in their progression from year to year of school. It is customary to present this content in strands along the lines of number, algebra, geometry, probability and statistics. At times this content is articulated as concepts, skills and procedures. Lastly, most new curriculum documents focus on applications and problem solving as important aspects to be developed with students. Undoubtedly, such topics dominate the majority of classroom's time and assessment instruments that teachers utilise. The value of mathematics for developing active citizenship requires that a shift be made away from mere content and procedures into problem solving and applications. Further, while it is usual to find applications in mathematics from science and natural world of the student, applications from the social life often remain neglected. Social applications

in mathematics are often seen as contrary to rigorous mathematics that is needed for higher studies and often dealt with in special less academic courses targeting less able students. However, this constructed binary might be counterproductive by denying the majority of students, taking the so called social or practical mathematics, the opportunity and the ability to develop their generalised abstractions of mathematical concepts and procedures. Further, in spite of the rhetoric of curriculum documents, and the assurance by many teachers that the two streams deal with equally valuable mathematics – albeit for different needs - for many students a hierarchy of values exists between them resulting in higher status to the formal academic mathematics. Dowling's (1991) empirical analysis which revealed that this division between academic and mundane mathematical practices effectively enabled the subject to act as a social class gatekeeper is thus a case in point.

Finally a mathematics education for citizenship approach implies a shift of sequencing to developing mathematics knowledge and its application. The common practice in many mathematics classrooms is that students develop mathematical understandings and skills before they are able to apply them in problem solving. Hence mathematical knowledge is often presented as decontexualised and abstract. This often leads students into asking "Why are we studying this?" and to students switching off mathematics before real and interesting applications are encountered. Mathematics education that promotes active citizenship must aim at not only developing mathematical knowledge and skills, but also knowledge and skills about the real world of the students. We argue that an alternative is for the use of real world activities that promote students' learning about their social world *while* they are learning mathematics and, at the same time, learn about mathematics *while* they are engaging with real world activities. Moreover, there has to be a balance between these two areas of learning. In particular, teachers need to always ask what mathematics, higher order mathematics in particular, is learnt by such activities and what significant learning about the social world is anticipated. In particular, they need to raise the question about have we learnt about mathematics, its assumptions, power and limitations as result of these activities.

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